WHAT IS CLAIMED IS

1. Change detection apparatus for detection of changes between first and second stereoscopic image pairs obtained at different times of a substantially similar view, the apparatus comprising:

a two-dimensional image filter for comparing said first and second image pairs to obtain an initial list of change candidates from two-dimensional information in said image pairs, and

a three-dimensional image filter for comparing at least one of said first and second image pairs at said change candidates using three-dimensional image information in said image pairs to retain change candidates correlating with three-dimensional image information and to reject change candidates not correlating with three-dimensional image information, thereby to produce a refined list of change candidates.

2. Apparatus according to claim 1, wherein said three-dimensional image filter is configured to compare three dimensional information in both said first and second image pairs, thereby to obtain three-dimensional change information, such that said retaining and said rejecting is on the basis of a correlation with said three dimensional change information.

3. Change detection apparatus according to claim 1, wherein said two dimensional information is color information.

4. Change detection apparatus according to claim 1, wherein said two-dimensional information is texture information.

5. Change detection apparatus according to claim 1, further comprising a movement elimination filter connected prior to said three-dimensional image filter, said movement filter comprising a two-dimensional comparator for comparing change candidates between images of said image pairs to eliminate changes occurring within an image pair as movement.

6. Change detection apparatus according to claim 1, further comprising an alignment unit for aligning respective ones of said images to allow filtering, said alignment unit comprising a tie point unit for identifying a first image feature on one of said images, carrying out one-dimensional cross-correlation to find a corresponding image feature on a second of said images and then doing a reverse one-dimensional cross-correlation from said corresponding image feature to find said first image feature, said first image feature and said corresponding image feature being accepted for aligning only if said first image feature is successfully found by said reverse one-dimensional cross-correlation.

7. A method of automatic change detection between earlier and later images of a scene, wherein two-dimensional and three dimensional data is available, the method comprising:

obtaining an initial list of candidate changes from said two-dimensional data, and

eliminating from said initial list those candidate changes which do not correspond to three-dimensional changes.

8. Change detection apparatus for detection of changes between first and second stereoscopic image pairs obtained at different times of a substantially similar view, the apparatus comprising:

a comparator for comparing at least candidate portions of each one of said first stereoscopic image pair at least with corresponding candidate portions of each one of said second stereoscopic image pair to obtain four measures of change thereat,

a thresholder for eliminating ones of said at least candidate portions of said image from a list of changes based on a lowest one of said four measures, thereby to refine said candidate list of changes.

9. A change detection method for detection of changes between first and second stereoscopic image pairs obtained at different times of a substantially similar view, the method comprising:

comparing at least candidate portions of each one of said first stereoscopic image pair at least with corresponding candidate portions of each one of said second stereoscopic image pair to obtain four measures of change thereat, and

eliminating ones of said at least candidate portions of said image from a list of changes based on a lowest one of said four measures, thereby to refine said candidate list of changes.

10. Epipolar validation apparatus for validation of features matched between first and second stereoscopic image pairs, the image pairs being obtained at different times of a substantially similar view, the apparatus comprising:

a first image feature locater for locating said feature in said first image,

a one dimensional cross correlator for carrying out a one-dimensional search to find said feature in said second image,

a reverse correlator for using said feature in said second image as a starting point and searching for said feature in said first image, and

a validator for accepting said match only if said feature in said second image leads to said feature in said first image.

11. Epipolar validation method for validation of features matched between first and second stereoscopic image pairs, the image pairs being obtained at different times of a substantially similar view, the method comprising:

locating a feature in said first image,

carrying out a one-dimensional search to find said feature in said second image,

using said feature in said second image as a starting point and carrying out a one-dimensional search for said feature in said first image, and

accepting said match only if said feature in said second image leads to said feature in said first image..

12. The method of claim 11, wherein said one-dimensional searches comprise cross-correlating.

13. A three-dimensional change detector unit for detecting changes between a first stereoscopic image pair and a second stereoscopic image pair, the apparatus comprising:

a preliminary processor for processing said first and second images to produce a candidate list of changes;

a digital terrain model creator for creating, from each of said stereoscopic image pairs, a first and a second digital terrain model respectively of at least positions indicated in said candidate list of changes from three-dimensional information in each stereoscopic pair,

a tie unit for finding corresponding points about said positions and for tying said points at the same heights in said first and second digital terrain maps,

a triangulator for triangulating within said tie points to eliminate changes that do not show up as height differences between said first and said second digital terrain maps, thereby to produce a refined list of changes.

14. A three-dimensional change detection method for detecting changes between a first stereoscopic image pair and a second stereoscopic image pair, the method comprising:

processing said first and second images to produce a candidate list of changes;

creating, from each of said stereoscopic image pairs, a first and a second digital terrain model respectively of at least positions indicated in said candidate list of changes from three-dimensional information in each stereoscopic pair,

finding corresponding points about said positions and tying said points at the same heights in said first and second digital terrain maps,

triangulating within said tie points to eliminate changes that do not show up as height differences between said first and said second digital terrain maps, thereby to produce a refined list of changes.

15. A three-dimensional change detector unit for detecting changes between a first stereoscopic image pair and a second stereoscopic image pair, the apparatus comprising:

a preliminary processor for processing said first and second images to produce a candidate list of changes;

a digital terrain model creator for creating, from each of said stereoscopic image pairs, a first and a second digital terrain model respectively of at least positions indicated in said candidate list of changes from three-dimensional information in each stereoscopic pair,

an equalizer for equalizing average height levels between said first and second digital terrain models, and

a high pass filter for detecting high frequency differences between said first and second digital terrain models to affirm changes in said candidate list having high frequency components and to eliminate changes not having high frequency components, thereby to produce a refined list of changes.

16. The detector unit of claim 15, further comprising a low pass filter connected between said digital terrain model creator and said equalizer for elimination of low frequency differences between said first and said second digital terrain models.

17. A three-dimensional change detection method for detecting changes between a first stereoscopic image pair and a second stereoscopic image pair, the method comprising:

processing said first and second images to produce a candidate list of changes;

creating, from each of said stereoscopic image pairs, a first and a second digital terrain model respectively of at least positions indicated in said candidate list of changes from three-dimensional information in each stereoscopic pair,

equalizing average height levels between said first and second digital terrain models,

detecting high frequency differences between said first and second digital terrain models to affirm changes in said candidate list having high frequency components, and

eliminating changes not having high frequency components, thereby to produce a refined list of changes.

18. Apparatus for registration of an aerial photograph with a reference orthophoto, the apparatus comprising:

a registration unit, and a cross-correlator for:

a) making an initial registration attempt between the aerial photograph or a reduced version thereof and the reference orthophoto, based on a first tie point,

b) carrying out a first cross correlation between the photograph and the orthophoto according to the registration attempt, to obtain a first correspondence measure,

c) at least once changing a parameter, making a new registration attempt between the aerial photograph or a reduced version thereof and the orthophoto, and carrying out a further cross correlation to obtain a further correspondence measure, and

a selector for selecting as an output the registration attempt yielding the highest correspondence measure.

19. Apparatus according to claim 18, wherein said parameter is a height parameter of said aerial photograph or a reduced version thereof.

20. Apparatus according to claim 19, configured to carry out stepwise changing of said height, and to make a registration attempt at each step.

21. Apparatus according to claim 20, wherein said step is substantially one meter.

22. Apparatus according to claim 18, wherein said parameter is an angle of said aerial photograph or a reduced version thereof.

23. Apparatus according to claim 22, wherein said parameter is initially an angle parameter, and wherein said registration unit and said cross correlator are configured to repeat stage c) wherein said parameter is a height of said aerial photograph.

24. Apparatus according to claim 22, operable to carry out stepwise changing of said angle within a range and to make a registration attempt at each step.

25. Apparatus according to claim 24, wherein said range is substantially ten degrees and said step is substantially one degree.

26. Apparatus according to claim 18, wherein said registration attempts are carried out on said reduced version and said reduced version is obtained from a pixel reduction unit located prior to said registration unit.

27. Apparatus according to claim 18, wherein said registration unit, said cross correlator and said selector are configured to repeat said initial and at least one further registration attempt for a second tie point.

28. Apparatus according to claim 27, wherein said registration unit, said cross correlator and said selector are configured to repeat said initial and at least one further registration attempt for a third and fourth tie point respectively.

29. Apparatus according to claim 28, further comprising a contour follower for following contours along diagonals between said four tie points to determine a quality of said output registration.

30. A method for registration of an aerial photograph with a reference orthophoto, comprising:

a) making an initial registration attempt between the aerial photograph or a reduced version thereof and the reference orthophoto, based on a first tie point,

b) carrying out a first cross correlation between the aerial photograph and said reference orthophoto according to said registration attempt to obtain a first correspondence measure,

c) at least once changing a parameter, making a new registration attempt between the aerial photograph or a reduced version thereof and the orthophoto, and carrying out a further cross correlation to obtain a further correspondence measure, and

d) selecting as an output the registration attempt yielding the highest correspondence measure.

31. The method of claim 30, wherein said parameter is a height parameter of said aerial photograph or a reduced version thereof.

32. The method of claim 31, further comprising carrying out stepwise changing of said height, and making a registration attempt at each step.

33. The method of claim 32, wherein said step is substantially one meter.

34. The method of claim 30, wherein said parameter is an angle of registration of said aerial photograph or a reduced version thereof.

35. The method of claim 34, wherein said parameter is initially an angular parameter, and wherein said method further comprises repeating stage c) wherein said parameter is a registration height of said aerial photograph.

36. The method of claim 34, comprising carrying out stepwise changing of said angle within a range and making a registration attempt at each step.

37. The method of claim 36, wherein said range is substantially ten degrees and said step is substantially one degree.

38. The method of claim 30, wherein said registration attempts are carried out on said reduced version and said reduced version is obtained by a pixel reduction process.

39. The method of claim 30, further comprising repeating said initial and at least one further registration attempt for a second tie point.

40. The method of claim 39, further comprising repeating said initial and at least one further registration attempt for a third and fourth tie point respectively.

41. The method of claim 40, further comprising following contours along diagonals between said four tie points to determine a quality of said output registration.

42. Apparatus for classification of tie points for registration of corresponding images, comprising:

a tie point identifier for identifying points in said corresponding images to serve as tie points, and

a classifier for classifying said identified tie points as stable or unstable tie points, thereby to eliminate unstable tie points and base said registration on stable tie points.

43. Apparatus according to claim 42, wherein said classifier uses a stability index to classify said tie points.

44. Apparatus according to claim 42, wherein said stability index includes color as a stability indicator.

45. Apparatus according to claim 44, wherein said classifier is configured to classify green as unstable.

46. Apparatus according to claim 44, wherein said classifier is configured to classify at least one of brown and grey as stable.

47. Apparatus according to claim 43, wherein said stability index is usable with automatic object recognition to recognize predetermined objects as being stable or unstable.

48. Apparatus according to claim 47, wherein said classifier comprises a feature recognizer for recognizing any of bare earth, buildings, rocks and stones as being stable.

49. Method for classification of tie points for registration of corresponding images, comprising:

identifying points in said corresponding images to serve as tie points, and

classifying said identified tie points as stable or unstable tie points, thereby to eliminate unstable tie points and base said registration on stable tie points.